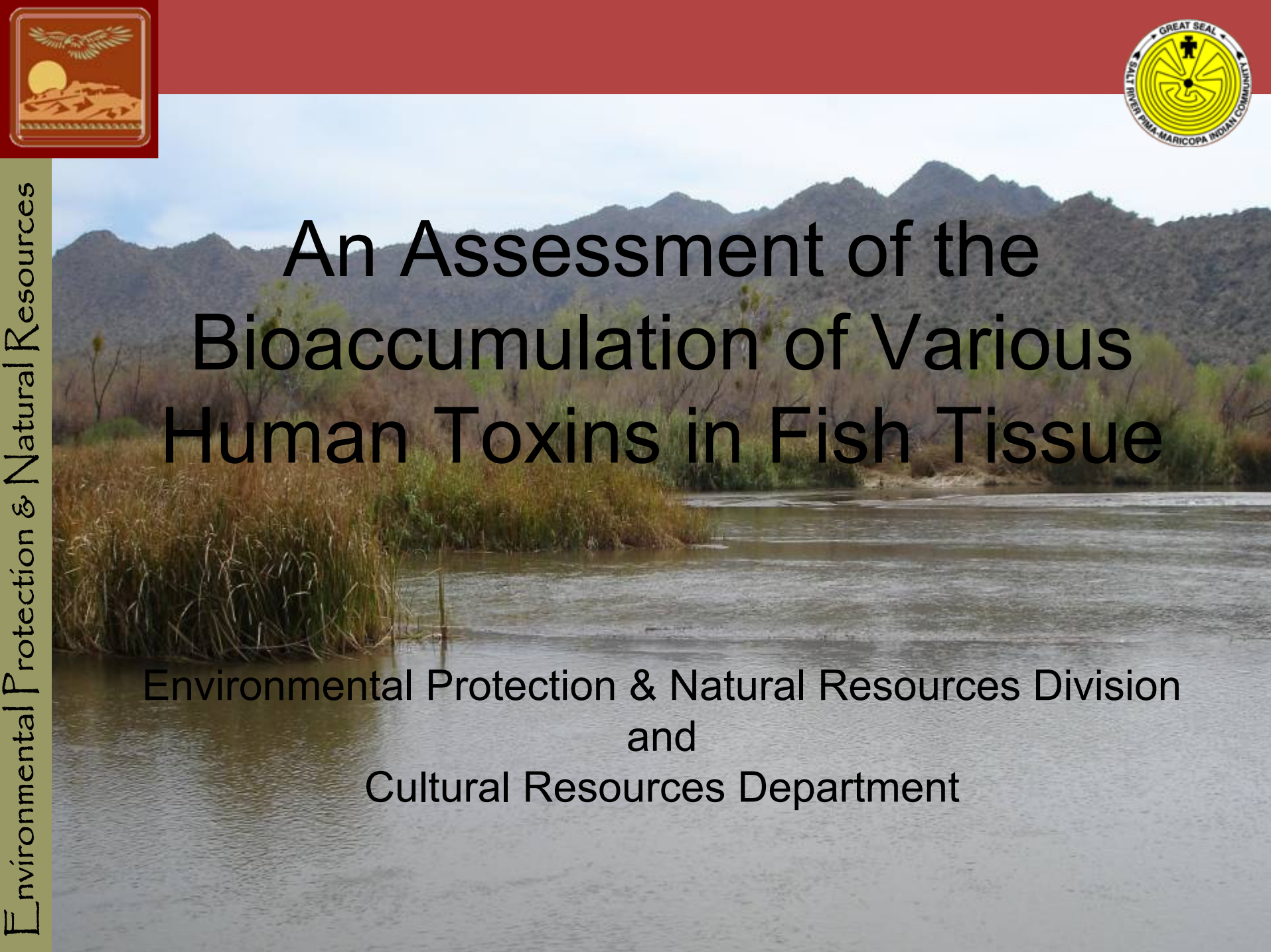
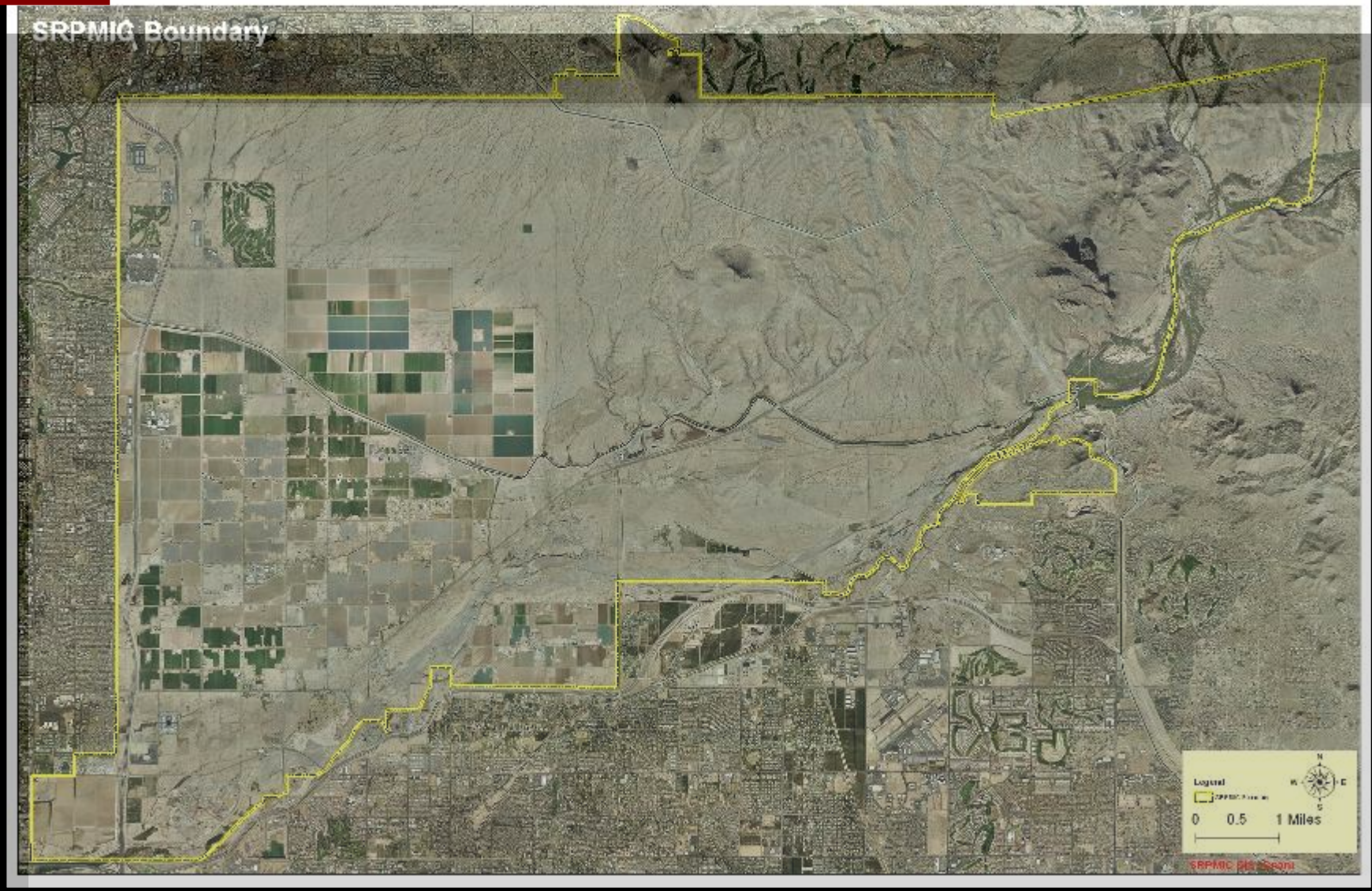


Environmental Protection & Natural Resources

An Assessment of the Bioaccumulation of Various Human Toxins in Fish Tissue

Environmental Protection & Natural Resources Division
and
Cultural Resources Department

Environmental Protection & Natural Resources

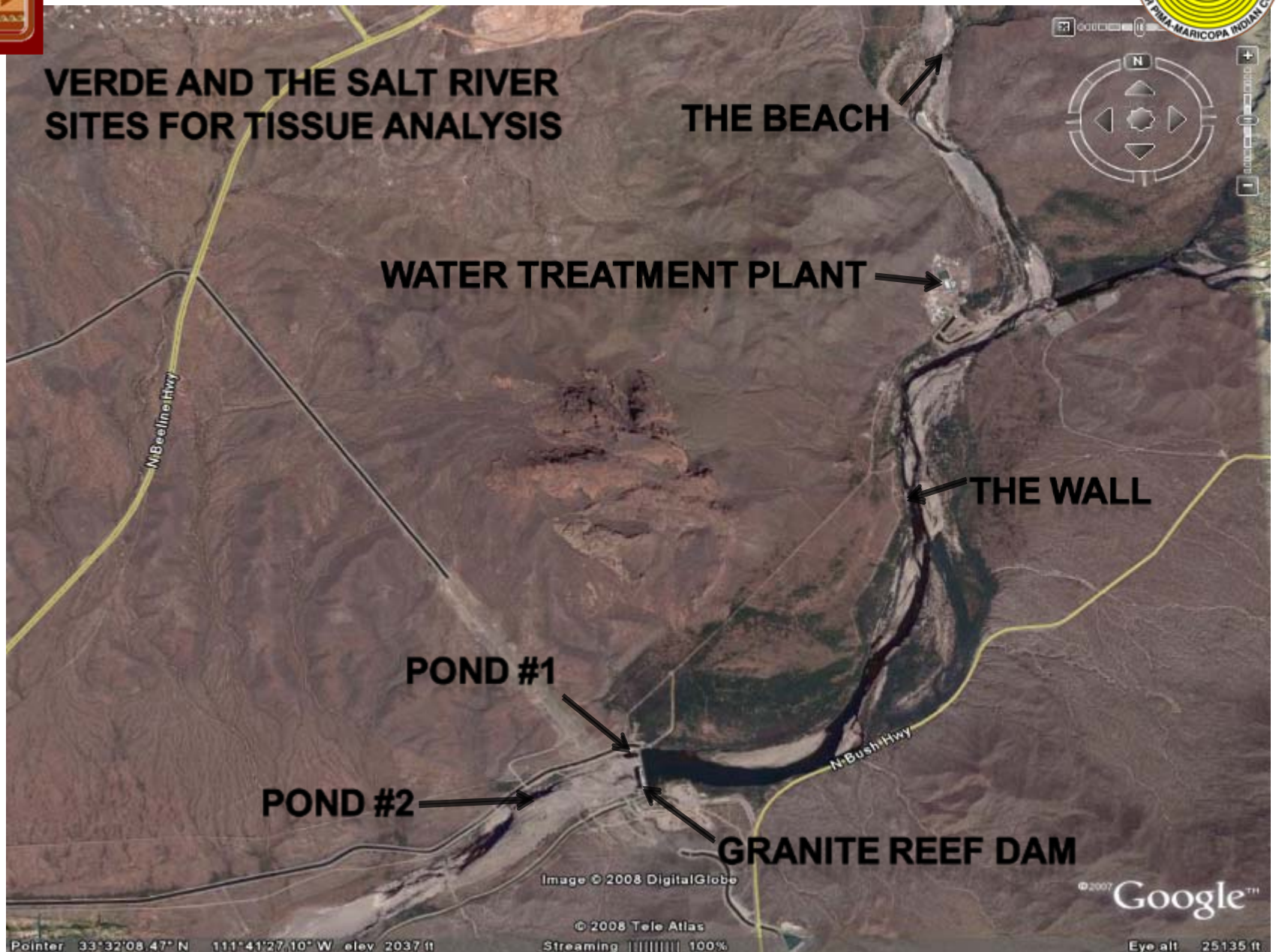


Project Background

- Concerns from Community Members on Fish Safety
- Enlisted help from Cultural Resources

4 Sampling Sites

- "The Beach"
- "The Wall"
- Pond #1
- Pond #2


VERDE AND THE SALT RIVER
SITES FOR TISSUE ANALYSIS
THE BEACH
WATER TREATMENT PLANT
THE WALL
POND #1
POND #2
GRANITE REEF DAM
N Beeline Hwy
N Bush Hwy
Image © 2008 DigitalGlobe
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Google

"The Beach"

- Verde River
- Between Pole 1 and 2
- Beach-like area with a large eddy

"The Wall"

- Salt River
- Above Granite Reef Dam
- High Potential for Variability in Fish Species

Pond #1

- Salt River
- Directly Below Flood Gates of Dam
- Water extremely turbid
- High algal growth
- Depth only 3-8ft

Pond #2

- Salt River
- Downstream of Granite Reef Dam near Bush Hwy
- Flows received through Drainage Pipes

Sampling Methods

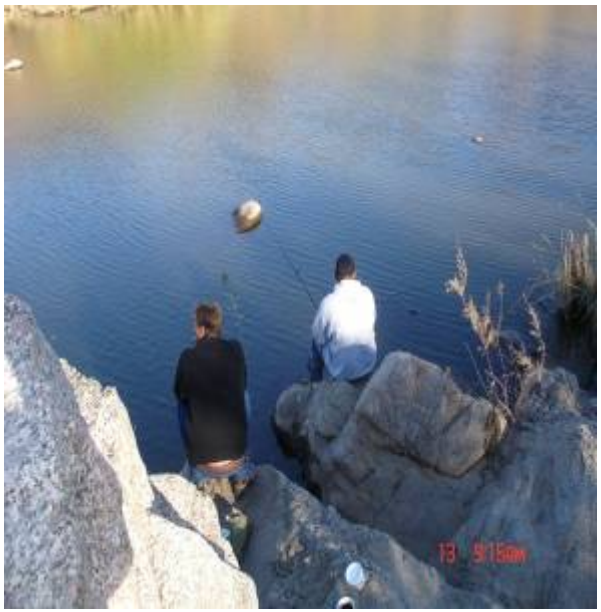
***NETS**

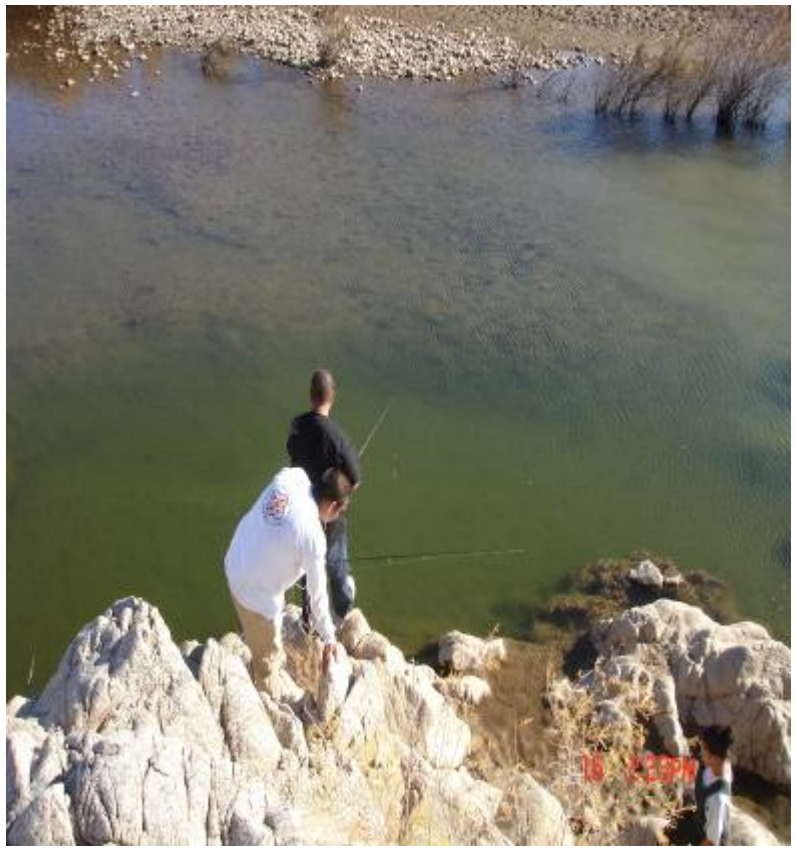
Sampling Methods

***Multiple Stream Line Fishing**

Sampling Methods

***Pole Harvesting**





Fish Species Harvested

Fish Tissue Processing

1. Fish were weighed individually.

Fish Tissue Processing

2. Fish were measured.

Fish Tissue Processing

3. Fish were visually inspected for lesions, etc.

Fish Tissue Processing

4. Photographed

Fish Tissue Processing

5. Scales were removed and fish filleted (skin & no skin).

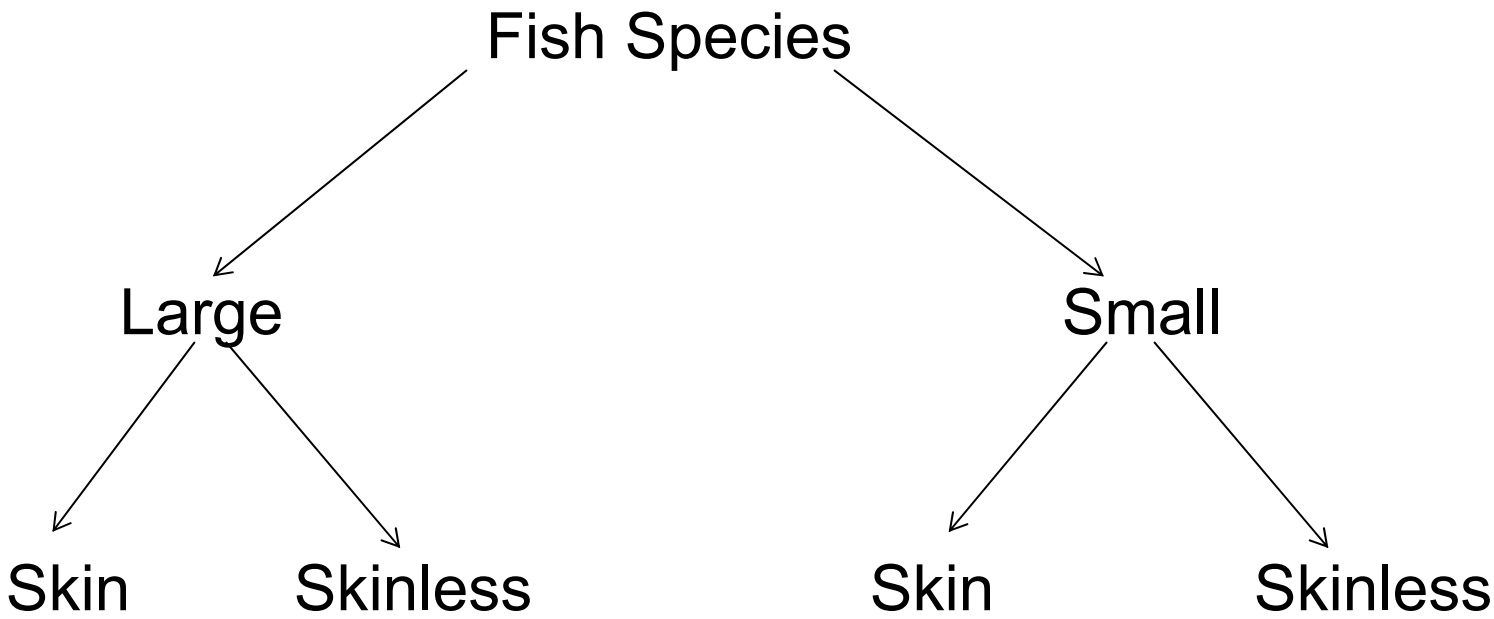
Fish Tissue Processing

6. Subsamples wrapped in foil and weighed

Fish Tissue Processing

7. Subsamples were bagged and put on ice.

Composite Scale



Toxins Analyzed

Carcinogens	Non-carcinogens
Total Inorganic Arsenic	Alpha/Beta-BHC
Aldrin	**Selenium**
Gamma-BHC (Lindane)	**Cadmium**
Chlordane	**Methylmercury**
DDD/DDE/DDT	Tributylin
Dieldrin	Endosulfan sulfate
Heptachlor/epoxide	Endosulfan I+II
Hexachlorobenzene	Endrin/aldehyde/ketone
Toxaphene	Mirex
PCBs (total)	Methoxychlor
PAHs	**Chlorpyrifos**
2,3,7,8-TCDD (dioxin)	
TEQs*	

*Estimated Total Toxicity Equivalency Quotient based on substituted dioxins and furans

RED – Detected in all fish species

GREEN – Detected in some fish species

Equations

Generation of the Maximum Monthly Fish Consumption Limit, CR_m (meals/month)

Non-carcinogenic Effects:

$$CR = \sum_{m=1} (RfD_m / C_m) * BW$$

$$CR_m = (CR * T)/MS$$

Carcinogenic Effects:

$$CR = RL * BW / \sum_{m=1} (C_m + CSF_m)$$

$$CR_m = (CR * T)/MS$$

CR = maximum allowable fish consumption rate (kg/d)

CR_m = Maximum Monthly Fish Consumption Limit

RfD = Oral Reference Dose (mg/kg-d)

BW = consumer body weight (70 kg)

C = concentration of a human toxin in fish tissue (mg/kg)

T = time average period (1 month = 30.44 d)

MS = meal size of uncooked fish fillet (0.227 kg/meal)

RL = maximum acceptable life risk level (10^{-5})

CFS = Cancer Slope Factor ($(mg/kg-d)^{-1}$)

Maximum Monthly Fish Consumption Limit, CR_m

Fish Species	CR_m*	Toxin Association
Channel Catfish	4.01 (4)	Methylmercury
Grass Carp	6.06 (6)	Methylmercury
Largemouth Bass	3.83 (4)	Methylmercury
Rainbow Trout	8.47 (8)	As + (DDD+DDE+DDT)
Sunfish	8.27 (8)	As + (DDD+DDE+DDT)
Bluegill	8.43 (8)	As + (DDD+DDE+DDT)

*Associated with a consumer body weight of 70 kg (154 lbs) and a meal size of 0.227 kg (8 oz) of uncooked fish fillet

Adjustments of Consumer's Body Weight and Meal Size on Maximum Monthly Fish Consumption Limit, $CR_{m,adj}$

$$CR_{m,adj} = CR_m * M_{BW} * M_{MS}$$

Where

$CR_{m,adj}$ = CR_m that is adjusted for a consumer body weight and meal size apart from the USEPA recommended 70 kg and 8 oz, respectively

CR_m = CR_m that is associated with the USEPA recommended consumer body weight of 70 kg and meal size of 8oz

M_{BW} = body weight multiplier (unitless)

M_{MS} = meal size multiplier (unitless)

Adjustments of Consumer's Body Weight and Meal Size on Maximum Monthly Fish Consumption Limit, $CR_{m,adj}$

Table 7. Consumer's Body Weights and Meal Sizes Multipliers

Consumer's Body Weight	Body Weight Multipliers	Meal Size	Meal Size Multipliers
kg	M_{BW}	oz	M_{MS}
10.0	0.14	2.0	4.00
15.0	0.21	2.5	3.20
20.0	0.29	3.0	2.67
25.0	0.36	3.5	2.29
30.0	0.43	4.0	2.00
35.0	0.50	4.5	1.78
40.0	0.57	5.0	1.60
45.0	0.64	5.5	1.45
50.0	0.71	6.0	1.33
55.0	0.79	6.5	1.23
60.0	0.86	7.0	1.14
65.0	0.93	7.5	1.07
70.0	**1.00**	**8.0**	**1.00**
71.0	1.01	8.5	0.94
72.0	1.03	9.0	0.89
73.0	1.04	9.5	0.84
74.0	1.06	10.0	0.80
75.0	1.07	10.5	0.76
76.0	1.09	11.0	0.73
77.0	1.10	11.5	0.70
78.0	1.11	12.0	0.67
79.0	1.13	12.5	0.64
80.0	1.14	13.0	0.62

Maximum Monthly Fish Consumption Limit, CR_m and $CR_{m,adj}$

Fish Species	CR_m*	$CR_{m,adj}$ **	Toxin (s) Association
Channel Catfish	4.01 (4)	4.56(5)	Methylmercury
Glass Carp	6.06 (6)	6.88(7)	Methylmercury
Largemouth Bass	3.83 (4)	4.35(4)	Methylmercury
Rainbow Trout	8.47 (8)	9.62(10)	As+(DDD+DDE+DDT)
Sunfish	8.27 (8)	9.39(9)	As + (DDD+DDE+DDT)
Bluegill	8.43 (8)	9.58(10)	As+(DDD+DDE+DDT)

*Associated with a consumer body weight of 70 kg (154 lbs) and a meal size of 0.227 kg (8 oz) of uncooked fish fillet

**Associated with a consumer body weight of 50 kg (110 lbs) and a meal size of 0.142 kg (5 oz) of uncooked fish fillet

Results

Maximum Monthly Fish Consumption Limits for a selected set of fish species harvested from the Community's surface bodies were generated using the approach and assumptions recommended by USEPA. The results of these will be used to issue Fish Consumption Advisories for Community Members in the near future.

The bio-accumulation of methylmercury by Channel Catfish and Largemouth Bass harvested from the Community's surface water bodies was found to be up to 5 times lower than the corresponding results of a recent Roosevelt Lake Study conducted by the State of Arizona.

Within a fish species, it appears that larger/older fish generally tends to accumulate a higher level of human toxins that of smaller/younger fish.

Within a fish species, tissue samples with intact skin generally tend to accumulate a higher level of human toxins than skinless sample.

Instead of testing an entire spectrum of human toxins, inorganic arsenic, methylmercury, and DDD+DDE+DDT can be used as indicator toxins when conducting future risk assessment on bio-accumulation of human toxins in fish from the Community's surface water bodies.

Environmental Protection & Natural Resources

Next Steps

1. Fish Tissue Report
2. Fish Consumption Advisories
3. Outreach


Environmental Protection & Natural Resources
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